THE PARTICIPATION OF MICRO-ORGANISMS AT THE FORMATION OF TODOROKITE FROM OXIDATION ZONE (TERÉZIA VEIN, BANSKÁ ŠTIAVNICA DEPOSIT, SLOVAK REPUBLIC)

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Todorokite has been identified at the Terézia vein in the Banská Štiavnica ore field. Todorokite belongs to the youngest minerals of the vein filling, confirmed by its position in the central part of the cluster cavities, often formed by perfect crystals of quartz. The grey-brown coloured, fine-grained aggregates of todorokite, having a characteristic metallic lustre, frequently fill the space among the crystals of quartz and often form crusts up to 4 cm thickness. Sometimes they form also spheroidal and reniform aggregates with radial to fibrous texture, built up of very small needle-like crystals.

The SEM images from reflected (back-scattered) electrons, obtained from various parts of sample under relatively great magnification, show that the sample is formed by plates, needles and tables of various length and width, and also by fibres and spheroidal aggregates of todorokite.

By scanning electron microscope (CAM SCAN-4) the typical gradual stratifying of the aggregate of todorokite was observed, which corresponds to the gradual natural forming of more layers within the aggregate.

Some layers are characterised by vertically curved basalt-shaped crystals and among them are situated the cohesionless interwoven mass of very thin fibres (probably mineralised basidia). Their presence is confirmed by their carbon content (C_{org} = 0.10–0.22%). Vertical structures with variable position of bacteria-like structures are often also present and/or fungus-like structure clusters at upper parts of the layers. The thickness of the fungus-like structures is several tenths of μm and the length several hundred μm.

Other layers form remicated, strongly cellular and porous fungus-like structures (thalluses) with marginal feathered and globular termination, which probably correspond to basidia. The thickness of these bacteria-like and/or fungus-like structures is up to 40–50 μm, the length of individual unicellular bodies is up to 200–300 μm. The terminal basidia reach the size of 15 to 30 μm.

Typically, there are also relatively large (20 to 40 μm) spheroidal forms (clusters of identical, partly disturbed) spheroidal remainders of micro-organisms or bacteria-like and/or fungus-like structures. Here the bacterial mucilage (probably glycokalyx, i.e. recrystallized microbial liquid) was probably partially preserved, metasomatised by todorokite. The well-preserved spheroidal remainders have an average size of 3 to 10 μm. The various maculose clusters (probably septa), cumulates, or the vertical off shoots can be observed on some fungus-like structures.

Closely vertical layers with systems of oval cavities–galleries, with fungus-like structures at the upper part of thalluses and strongly cellular structures with the fungi (probably basidia) of spheroidal shape, with a size up to 15 μm, were also observed. The cohesion's knitting-through is observed among the relatively compact thalluses, where the fibrous structure is clearly seen. The thin fibres of the fungus-like structures are not always totally mineralised.

Up to now not exactly identified euhedral rhombohedral crystals (probably Ca-Mn carbonates) were been formed at the cavities of the cellular structures of the above described aggregates.

The quantitative analyses of the sample were converted to the following empirical formula of todorokite: $(Na_{0.25}K_{0.15}Ca_{0.45}Zn_{0.16})_{1.01}(Mn^{4+}_{5.20}Mn^{2+}_{0.45}Mg^{2+}_{0.34})_{5.99}O_{12}\cdot 3H_2O$. The quantity of water in the given formula and the distribution of cations within the formula is analogous with the formula given by STRACZEK et al. (1960). The basic diffraction lines are 9.58 Å (100), 4.82 Å (50), 2.45 Å (40), 2.360 Å (30), 1.971 Å (20), 1.422 Å (40). The structure is nearest to the orthorhombic lattice with parameters: a = 9.75 Å, b = 2.84 Å and c = 9.6 Å (Z = 1). Nevertheless, at basic masses this todorokite is characterised by the disordered structure. It appears, that in the oxidised zone micro-organisms participate also in the creation of todorokite (presence of todorokite pseudomorphs of various parts of fungi, seldom a woodruffite mass).

Reference

STRACZEK, J. A., HORER, A., ROSS, M. & WARSHAWCH, M. (1960). Amer. Mineral. 45: 1174-1184.